Optics Education: Supply and Demand

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ABSTRACT

During the spring of 1988 a survey was sent to 70 schools and 35 industries identified as having a particular interest in optics. The objectives of the survey were to determine the number of optics degrees being granted, the nature of the schools granting the degrees, and the demand for the graduates. The results indicate a rich diversity in optics education and a continuing high demand for students with optics degrees.

1. INTRODUCTION

As the committee planning this conference began its work, it became clear that there existed very little recent information on optics education programs and the opportunities that exist for their graduates. Thus, with the assistance of Rich Donnelly of the SPIE office, two survey forms were prepared; one to be sent to academic institutions and another to industries. A total of 70 forms were sent to all institutions listed in the last edition of Optics in Education as well as several other institutions not listed. This survey emphasized BS & MS level programs, although results were obtained for AAS and PhD programs as well. Requests were also sent to 35 industries randomly selected from the 177 Sustaining Members of SPIE. As of July 20th, responses have been received from 41 academic units and 12 industries, which are the basis for the data which follows. I will continue to update this information as late responses arrive and hope to provide a more complete analysis at some time in the future.

2. OPTICS EDUCATION

From the outset, one of the major problems was the definition of "optics education". I took a very pragmatic approach. If you said you did it, you are included in the results. I did, however, attempt to sort the responses to provide a practical definition. Of the 41 schools responding, 24 self-identified themselves as having a "broad base" optics program and 17 identified themselves as a "specialty" within a traditional academic unit. Thus, all respondents felt they specialized to some extent in optics. However, only 16 had optics course distribution requirements and only 17 formally recognized optics as an area of study on the student's academic record.

Another test of "optics" was to look at courses that were available. I provided a screening based upon the number of schools that offered at least one course from each of the following three groups:

1) Geometrical and Physical Optics.
2) Optical Instruments, Optical Fabrication, Detectors & Sources, Optical Testing, and Lens Design.
3) Quantum Optics, Electro-Optics, Digital Image Processing, Fourier Optics, and Electronics.

Only 16 schools passed this test, the criteria being primarily the optical engineering courses represented by group 2. These 16 schools accounted for approximately 75 percent of the Bachelor's optics degrees that were reported. It should be noted that only 5 schools reported offering instruction in optics fabrication and only 8 offered lens and/or optical system design.

If there is any conclusion to be drawn it is that the number of identifiable "optical engineering" programs is probably between 8 and 24 and that many of the programs responding to the survey offer various degrees of optics or electro-optics as an opportunity within, and as a proper part of, a traditional science or engineering program. That is not intended to be a value judgment about the relative merits of the various alternatives.

3. DEGREES GRANTED

Table I shows the optics degrees granted in 1987 and those expected to be granted in 1989, as well as the ratio of part/full-time students.

Table I. Optics Degrees Granted for 1987 and 1989

	1987 and 1989		Ratio of Part-time/Full-time
AAS	95	94	34%
BS	366	429	4%
MS	243	258	33%
PhD	60	84	2%

For the 1987 data, I have looked at the academic units granting the degree, as shown in Table II. Physics and Electrical Engineering departments were two of the major sources. The two largest single contributors to the totals were the Institute of Optics of the University of Rochester and the Optical Sciences Center of the University of Arizona, which I show as separate entries.

Table II. 1987 Degrees by Source

	TOTAL	EE	Physics	U of R	U of Az
BS	366	160	73	96	0
MS	243	92	38	42	15
PhD	60	18	14	7	18

4. SALARIES

Average starting salaries for graduates reported by those at colleges and universities agreed well with the salaries that industrial respondents were expecting to pay (see Table III). It was tempting to try to sort this information by geographical location, but there is not an adequate amount of data to reach a meaningful result. I might note that the legendary "West-coast aerospace industry effect" was not immediately apparent.

Table III. Starting Salaries

Reported by Schools:	Average	Min	Max
AAS	$19,200	$16,000	$21,000
BS	$28,100	$18,000	$32,000
MS	$35,300	$23,000	$47,000
PhD	$43,600	$37,000	$50,000
Reported by Industry:			
AAS		(not available)	
BS	$28,000	$26,000	$30,000
MS	$35,000	$32,000	$39,000
PhD	$47,000	$42,000	$50,000

5. SUPPLY VS. DEMAND

One of the initial objectives of this survey was to substitute some numbers into the supply and demand equation. The results are elusive, but I can suggest a result. Table IV presents optics degrees granted by institutions responding to the

survey and job openings reported by industry. Job openings have been scaled to reflect the 12/177 ratio of survey returns vs. total SPIE membership. The limited number of responses does not inspire confidence in the accuracy of the industrial results.

Table IV. Degrees Granted vs. Reported Employment Opportunities

	Degrees Granted (1987)	Job Openings (Adjusted Survey Results)
BS	366	133
MS	243	118
PhD	60	89

This table is clearly at variance with another survey result which was quite clear; almost universally schools reported that students had an easy time finding a job and industry reported that it was difficult to recruit optics employees. Thus, the following comments:

1) Industries other than SPIE sustaining members are, of course, allowed to hire optics graduates, yet SPIE members alone were polled. Thus the number of openings is certainly underestimated from this cause alone. Additionally, there are a large number of government laboratories and independent foundations and institutes that are not represented in SPIE membership. This second group of employers is estimated to employ up to 25 percent of the optics graduates at all degree levels. Thus, the job openings at all degree levels is clearly underestimated.
2) Inquiries to several industrial respondents indicated that when they responded they were thinking of job openings for graduates from a formal optics program, i.e., if they were hiring a physics or EE graduate to work in optics or electro-optics, the opening would not have been reported here, (but the student's availability may have been reported on the supply side as an "optics" student). To achieve consistency, the number of available students would need to be revised downwards, or job openings upward.
3) For BS students, a large percentage were estimated to be going on for further academic work. Thus, while 366 were graduating, something closer to half might actually be entering the job market. The same effect operates to a lesser degree at the MS level.
4) For Master's degrees another effect is at play. A large percentage of the degrees are awarded to part-time students, who I assume are already employed. The academic survey reported that most of the part time students did not change employer upon completion of the degree and, therefore, do not enter a labor market.
5) If the supply side is underreported, it is due to schools that choose not to reply. Inspection of this list shows it is populated primarily by physics and EE programs without clearly identifiable optics programs, and I would choose not to scale the number of degrees upwards to account for the missing responses.

At this time I can only estimate the above effects and offer Table V as a preliminary indication. This table was produced by estimating the various adjustment factors based upon survey information. The largest inequality appears to exist at the PhD level and this is the level requiring the least adjustment. I suspect that the inequality holds at all levels, but perhaps not to the same extent. The clearest indication is still probably the one I began this discussion with; it is still relatively easy to find a job and hard to hire an employee.

Table V. Estimate of Job Seekers vs. Job Openings

	Job Seekers	Employment Available
BS	<200	>>200
MS	120	>150
PhD	60	150

6. GENERAL INFORMATION

Some general summary information is reported in Table VI relative to the location and size of the program.

Table VI. Summary Information on Optics Programs as Reported

Years in Existence	12 (average)	1 (min)	59 (max)
Full Time Faculty Involved:	247 (total in all programs)		
Part-Time Faculty Involved:	144 (total in all programs)		
Number of Programs Expecting Growth of:			
2X or More	7		
Modest Growth	18		
Stable at Current Level	11		
Decrease	1		
Location of Programs:			
Electrical Engineering	15		
Physics Department	15		
Other	8		
2 Year Programs	3		

Academic respondents were asked to express an opinion on various concerns that they had relative to their program. These are presented in a summary form in Table VII. The problem of "finding qualified staff" was high on the list of most of the institutions that had formal optics programs but did not appear often for a program imbedded in a physics or EE department.

Table VII. Concerns Expressed on Survey

22 to 16 Responses	
	Educational Program Funding
	Research Funding
	Attracting Qualified Students
	Recongnition of Program by Others
15 to 13 Responses	
	Scholarship Funds
	Finding Qualified Staff
11 Responses	
	Establishing Interfaces with Industry

"Recognition" does seem to occur across the board. This applied to recognition of optics by incoming students and their counselors and also recognition within larger academic units. This effect as it relates to students was confirmed by the fact that for BS level institutions the number of incoming students aware of optics as a career choice was estimated to be between 0 percent and 10 percent. As one might expect, this percentage was much higher (80 percent to 100 percent) for incoming graduate students.

And finally, a tally of the votes on the issue of the OSA or SPIE providing an accreditation of optical engineering programs given in TableVIII. The results indicate a clear unambiguous "maybe" within both industrial and academic responses. Written comments suggested that existing accreditation structures be explored and raised question about how accreditation would work within physics and EE departments. Concern was expressed about the necessarily "exclusive" nature of this accreditation process, particularity as applied at the undergraduate level.

Table VIII. Accreditation

	Response	
	Academic	Industry
Yes	3	1
Perhaps	21	7
No	9	3

7. CONCLUSION

I have no summary comments other than those already offered, as I consider this study still very much in-progress. I will update the information as, (and if), I receive late responses. My objective is to have a more detailed and complete accounting available by year's end. I will be happy to mail a report to those interested in receiving it when it is available.